Small Business Innovation Research/Small Business Tech Transfer

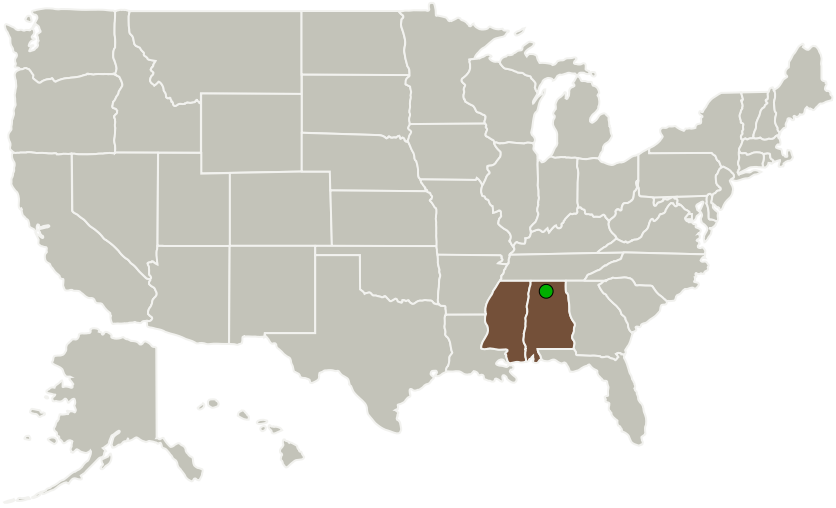
High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment, Phase II

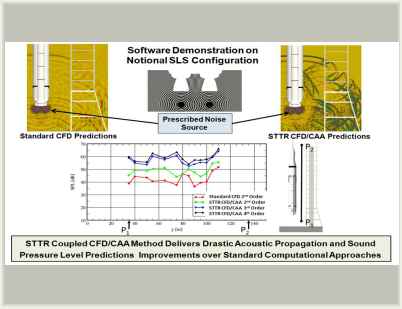
Completed Technology Project (2014 - 2018)

Project Introduction

Launch vehicles experience extreme acoustic loads during liftoff driven by the interaction of rocket plumes and plume-generated acoustic waves with ground structures. Currently employed predictive capabilities are too dissipative to accurately resolve the propagation of waves throughout the launch environment. Higher fidelity non-dissipative analysis tools are critically needed to design mitigation measures (such as water deluge) and launch pad geometry for current and future NASA and commercial launch vehicles. This project will develop and deliver breakthrough technologies to drastically improve acoustic loads predictions. An innovative hybrid CFD and Computational Aeroacoustics (CFD/CAA) method will be developed where established RANS/LES modeling will be used for predicting the acoustic generation physics, and a high-order accurate unstructured discontinuous Galerkin (DG) method will be employed to propagate acoustic waves across large distances using ideally suited high-order accurate schemes. This new paradigm enables: (1) Improved fidelity over linear methods; (2) Greatly reduced numerical dissipation and dispersion; and (3) Improved acoustics modeling for attenuation, diffraction, and reflection from complex geometry. A proof-of-concept was developed and successfully demonstrated during Phase I for benchmark applications as well as SLS prototype model launch environments. Phase II will deliver production CFD/CAA predictive capabilities with 4th-order spatial and temporal accuracy for near lossless acoustic propagation throughout the launch environment, which will provide NASA engineers with more than a two-fold increase in the range of resolvable frequencies over current methods.

Primary U.S. Work Locations and Key Partners





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Completed Technology Project (2014 - 2018)

Organizations Performing Work	Role	Type	Location
CFD Research Corporation	Lead Organization	Industry	Huntsville, Alabama
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Mississippi

Project Transitions

September 2014: Project Start

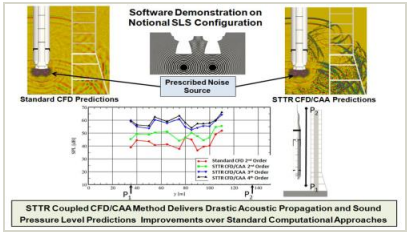
June 2018: Closed out

Closeout Summary: High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment, Phase II Project Image

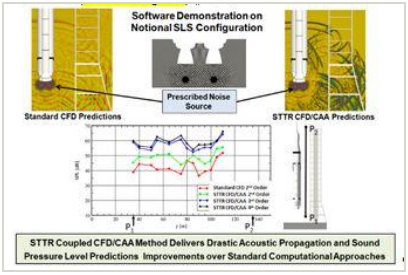
Closeout Documentation:

- Final Summary Chart Image*(https://techport.nasa.gov/file/137563)*

Images



Briefing Chart Image
High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment, Phase II *(https://techport.nasa.gov/image/130044)*



Final Summary Chart Image
High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment, Phase II Project Image *(https://techport.nasa.gov/image/131098)*

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
CFD Research Corporation

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Robert E Harris

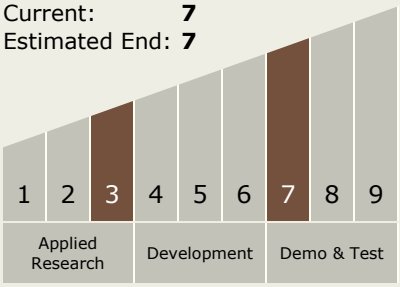
Co-Investigator:
Robert J Harris

High-Fidelity Prediction of Launch Vehicle Lift-off Acoustic Environment, Phase II

Completed Technology Project (2014 - 2018)

Technology Maturity (TRL)

Start: **3**
Current: **7**
Estimated End: **7**



Technology Areas

Primary:

- TX13 Ground, Test, and Surface Systems
  - TX13.2 Test and Qualification
    - TX13.2.8 Environment Testing

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System